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SOME TECHNICAL FACTORS AFFECTING THE ACCURACY OF RECORDING IN ELECTROMYOGRAPHIC INVESTIGATIONS

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Introduction

DURING the past half-century understanding of the physiological mechanisms of nerve and muscle has advanced considerably. This progress has been due, in no small measure, to the introduction of more accurate methods of recording, which allow the rapid small electrical concomitants of nerve and muscle activity to be faithfully reproduced for inspection and analysis. Of the various techniques used in the study of these problems, that of electronic amplification and recording has proved itself superior for many purposes. Until more recent years, however, the use of electronic techniques by the biologist was confined almost exclusively to the research laboratories, and such methods were rarely used to aid the clinician. This state of affairs is now changing. The techniques of the electronic engineer are being utilized in the design of apparatus to assist in the diagnosis and treatment of the sick, and are proving worthy adjuncts to older methods.

One such diagnostic aid which is finding increasing use is electromyography. The uses and validity of this method of examination have been amply shown by such workers as Smith (1934), Denny-Brown (1949) and Richardson (1951*a*), and it may safely be assumed that this means of investigating neuro-muscular problems will continue to find progressive popularity as its advantages become more widely appreciated. However, as with all new methods of investigation, the limitations and pitfalls of the apparatus involved, and at least an elementary knowledge of its method of operation, must be understood if there is to be

confidence in its use. To attempt a complete technical survey of electromyographic methods is beyond the scope of this paper, and would only result in the repetition of many topics which have already been adequately described elsewhere (Parnum, 1945; Dickinson, 1950). However, there have been few papers which have dealt with the more common forms of distortion which waveforms may undergo during their passage through an imperfect amplifier, and it is to the consideration of some such causes of distortion that this paper is almost entirely devoted. The treatment of the problems is non-mathematical, and obscure technical detail has been excluded in favour of more general considerations. In addition, the references given are generally to papers of such a nature that they can be appreciated by readers with a limited knowledge of electronics.

Although a relatively young study, electromyography has already progressed beyond the stage at which it concerned itself solely with the presence or absence of electrical activity in a particular muscle or muscle group, and interest is now focused also on such subjects as the shape of the waves recorded. While no thorough fundamental study of the causation of some of the waveforms described in the literature has yet been attempted, it must be remembered that the fundamental theorems necessary for determining current distribution in volume conductors were first described by Helmholtz (1853) and have more recently been elaborated in a study by Lorente de Nó (1947). It is thus seen that at least some of the mathematical tools necessary for such an analysis are available provided the waveforms observed are true replicas of those occurring *in situ*. If, however, the amplifier being used produces alterations in the shape of the wave between the time it is received at the recording electrodes and the time it is finally displayed for the investigator, the problems of analysis and interpretation become increasingly difficult. In addition to these difficulties, a faulty amplifier producing distortions renders the direct comparison of records obtained with it and those obtained from a different amplifier extremely hazardous. While it is possible, given a distorted record and knowing all the characteristics of the amplifier used, to work back and deduce the actual form of the wave when picked up, the advantages of accurate recording in terms of both time and effort saved, are obvious.

General Considerations

In assessing the suitable design of amplifiers for electromyography it is first convenient to consider the type of waveforms commonly met in clinical investigations. Examples of a fibrillation potential, a normal motor unit potential and a polyphasic motor unit potential are reproduced in Fig. 1. The records have been published elsewhere (Richardson, 1951*b*) and are reproduced by kind permission of the author. In order to obtain standard waveforms for the subsequent illustrations in this paper

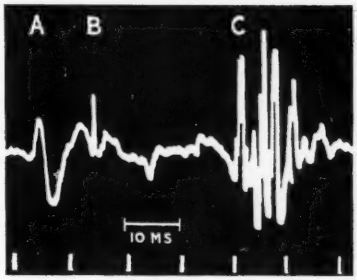

FIG. 1.
Electromyographic recording showing: (*a*) Normal motor unit, (*b*) Fibrillation potential and (*c*) Polyphasic motor unit potential.

of the effects of various types of amplifier distortion, synthetic electronically generated potentials have been used (Bauwens, 1950). Examples are reproduced in Fig. 2 for comparison with the true muscle potentials.

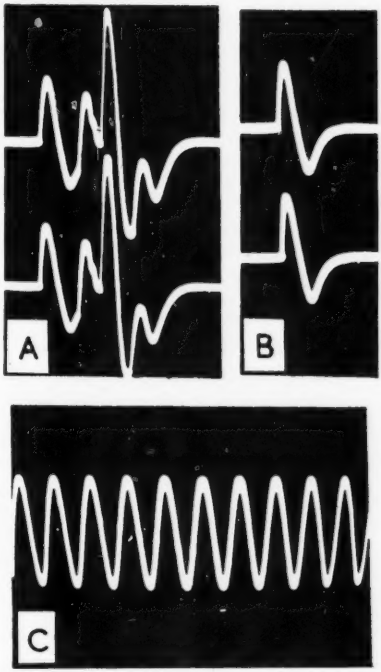

FIG. 2.
Synthetic action potentials. In this and subsequent Figures the lower trace of each pair shows the waveform as applied to the input of the amplifier under test, and the upper trace the waveform recorded from the output of the amplifier. (*a*) Accurate amplification of polyphasic potential. (*b*) Accurate amplification of diphasic potential. (*c*) Single trace of 1,000 c.p.s. time scale applicable to all traces in Figs. 2 to 8.

It will be observed that all the potentials are complex in nature, by which it is meant that they are not pure sinusoidal waves. In spite of the fact that the waveforms are not regularly repeated, it is possible to break down such complex potentials into a number of simple sinusoidal waves of differing frequency, amplitude and phase relationship, the algebraic addition of which results in the restoration of the original pattern. Such a process of breaking down complex waves to their elementary components is known as harmonic analysis. Further, it is sometimes possible to express the result of an harmonic analysis in the form of a Fourier series. The principles enumerated above have been applied to the analysis of a square wave in an extremely illuminating article by Scroggie (1945).

The methods of waveform analysis, which are described briefly by Low, and in more detail by Manley, provide the key to the logical design of amplifiers for electromyography. The fact that every wave pattern may be resolved into a series of simple sinusoidal waves allows one to specify the necessary range of frequencies which must be accurately amplified in order that a given complex wave may be faithfully reproduced. Since waveform distortion may be due to the inability of the amplifier to reproduce either or both high or low frequencies, it is first necessary to ensure that the instrument design allows the passage of the highest and lowest frequency sinusoidal waves likely to be encountered as components of the complex waveforms to be recorded, without these frequencies showing relative attenuation or relative phase shift. Ideally it is also advantageous to attenuate intentionally all frequencies other than those it is desired to reproduce. A frequency response better than necessary will increase the noise level of the amplifier without enhancing the accuracy of the desired waveform. Conditions approaching this ideal of a sharp cut-off to the pass band may be obtained by the use of a filter network, care being taken that non-linear phase shift with frequency in the pass band is avoided as far as possible (Buller and Styles, 1951*a*).

The extremes of frequency coverage desirable for the accurate recording of muscle action potentials are not finally established. It is certain, however, that direct coupled (D.C.) amplifiers which respond accurately down to zero frequency are neither desirable nor necessary for routine investigations. Faithful reproduction of the majority of potentials encountered in electromyography will be accomplished with an amplifier having a linear response from 50 c.p.s. to 3 Kc.p.s.

High Frequency Distortion

It is now necessary to examine some of the more important factors which determine the overall frequency response of a particular amplifier. The nature of the recording electrodes used will not be discussed in detail, but they must be considered in so far as they affect the source impedance

presented to the first stage of the amplifier. By the term source impedance is meant the compounded resistance and capacitative reactance presented by the tissue and contact resistance between the two input leads of the first stage. The three common types of electrodes in use for electromyography are:

1. Surface electrodes, which allow the recording of all electrical activity occurring between their extremities.
2. Single pole needle electrodes, which record from a large area but which may be used for localization.
3. Concentric needle electrodes in which the barrel of the needle is usually earthed to provide a shield for the central electrode. This arrangement results in a limited field of pickup and allows accurate localization.

Of these three types, the use of the first presents the amplifier with the lowest source impedance amounting to some 2,000 ohms per square centimetre of good surface contact, and the last presents the highest source impedance, which, though showing wide variations, may be in excess of 500,000 ohms. As a result of the possibility of such large source impedances, the method of connecting the electrodes to the first amplifying stage is of paramount importance. For reasons of convenience it is often desirable to separate the amplifier from the patient by a distance of some feet, and in these cases the necessary high gain of the amplifier usually demands the use of screened connecting wires. Such screened leads may have a capacitance of 50 pF/foot. The combination of a source impedance of 500 K ohms and a stray capacitance of some 200 pF, due to 4 ft. of screened cable, will result in considerable attenuation at high frequencies, the amplification at 4·15 Kc/s being only half that at 500 c/s. The reason for this may be appreciated by considering the source impedance and the resistance of the stray capacity to alternating current (more usually termed the capacitative reactance) as forming a potential divider across the signal source (V in). (See Diagram I.) The signal (V sig)

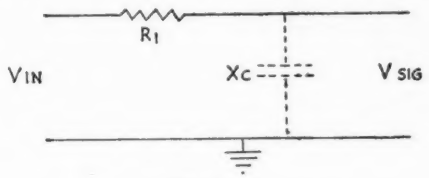

DIAGRAM I.

applied to the grid of the valve will depend upon the ratio of the reactance of the stray capacity (Xc) to the total impedance of the source (R1) in series with Xc, but while the value of the resistance is fixed the value of the reactance varies, becoming progressively less with increasing frequency.

Thus the higher the frequency of the waves at the electrodes, the smaller will be the signal actually applied to the first amplifying stage, due to the stray capacity behaving as a variable resistance which automatically decreases in value with increase in frequency.

An illustration of the increasing attenuation with increasing frequency produced by a three-foot length of single-braided cable feeding a triode valve is illustrated in Fig. 3; while the resultant distortion of a rectangular

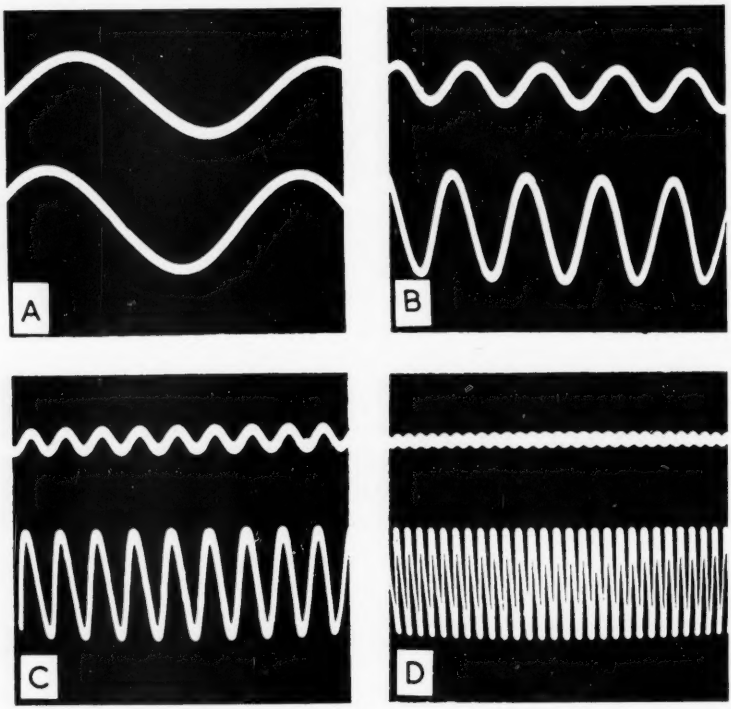

FIG. 3.
Loss of amplification at higher frequencies. (*a*) 140 c.p.s. (*b*) 500 c.p.s. (*c*) 1,000 c.p.s. (*d*) 3,000 c.p.s. Lower trace input, upper trace output. Figs. 3 to 6 were obtained with a source impedance of 2·2 MΩ and a screened lead with capacitance of 300 pF.

wave and the synthetic polyphasic action potential due to the same cause is demonstrated in Fig. 4. It should be noted that the effect described is largely produced before the first amplifying stage is reached, and therefore, although an amplifier undergoing tests on a workshop bench may have the required frequency response when the signal is applied directly to its input, this may apparently be lost when the instrument is put into clinical

use with additional leads appended. The type of distortion illustrated is obviously too serious to be tolerated, but since the source impedance is for all practical purposes constant and, as already stated, it is often

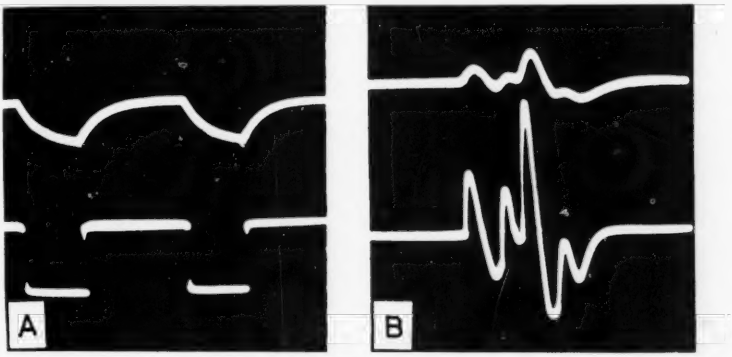

FIG. 4.
Effect of high frequency loss as illustrated in Fig. 3 on (*a*) rectangular wave and (*b*) polyphasic potential.

impracticable to shorten the recording leads below a certain length, some other method of avoiding the effect must be employed. What is required is a means of lowering the source impedance to the screened cable, and this may be achieved by placing a valve arranged as a cathode follower as close to the recording electrode as possible. The principles of operation of cathode followers are described by "Cathode Ray" (1945) and in more detail by Parker (1948), but the main features of such an arrangement are its high input impedance and low output impedance (which in the case being considered is the source impedance to the screened cable). The result is to nullify the effect of the stray capacity, as this is fed by the very low output impedance of the cathode follower (usually less than 1,000 ohms) instead of the high source impedance of the recording electrode. Against these obvious advantages must be set the fact that the overall amplification of a cathode follower is always less than unity. However, this drawback is not so serious as might at first appear, since the difference between the gain of the stage and unity may be kept small by appropriate circuitry (Buller and Styles, 1951*b*). The reduction in high frequency loss accompanying the introduction of a cathode follower at the electrode end of the screened cable is illustrated in Fig. 5.

While it is sometimes possible to house the cathode followers in a control unit close to the recording electrodes, the provision of the necessary heater and high tension supplies to a point separate from the main power pack may prove inconvenient. In these circumstances the arrangement described by Attree (1949), utilizing a cathode follower located at

the main amplifier end of the connecting leads, and double screened cable, may prove satisfactory. The type of cable he describes, which has two separate screens separated by an intersheath, is available commercially.

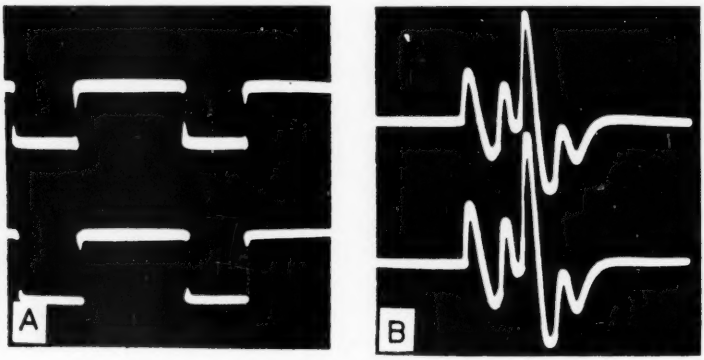

FIG. 5.
Amplifier as in Fig. 4, but with a cathode follower stage inserted close to the signal source. Note marked reduction in high frequency loss.

The principle of the method, which aims at decreasing the capacitance of the lead, is similar to that of the Kelvin Guard Ring. The inner of the two screened layers is connected to the cathode of the valve and consequently varies in voltage in approximately the same manner as the input grid. The outer screen is connected to earth and the resultant capacity of the central lead to the earthed screen is decreased by a factor of approximately ten. The photographs reproduced in Fig. 6 illustrate the improvement possible from Fig. 4 by this means. A further advantage claimed

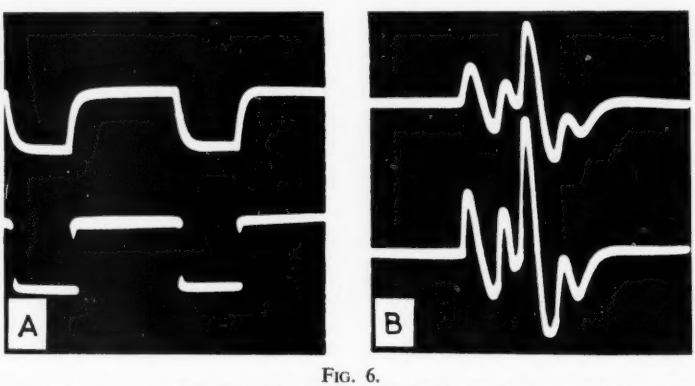

FIG. 6.
Amplifier as in Fig. 4, but with the addition of Attree's technique for reducing the capacitance of the input leads. Note the improvement on Fig. 4.

of this method is the almost complete disappearance of microphony from the cable (Svedberg, 1949).

It is perhaps pertinent to mention at this point that although the description of the means of preventing high frequency losses has been confined to the input circuit, the same considerations must be borne in mind whenever signals containing high frequency components are fed from a source of high impedance via a cable with appreciable stray capacity. For example, a long length of screened cable coupling the output of the last amplifying stage to a cathode ray tube will produce high frequency attenuation which may be remedied in an exactly similar manner to that described above for an input stage.

First Amplifying Stage

So far no consideration has been given to the most desirable design of the amplifier and to such decisions as whether an unbalanced system, i.e. input between one grid and earth, or balanced system, i.e. input between two grids, should be employed, and whether the same system should be used throughout the amplifier. It is not proposed to enter into such subjects in detail, since these matters, including the advantages to the biologist of the balanced, or double-ended input, have already been stated by such writers as Matthews (1934) and Parnum (1945). However, it may be stated that the balanced input is generally to be preferred because of its discriminating action between signals in phase at the two grids and signals out of phase at the grids, the former, which includes the majority of hum pickup, receive little amplification, while the latter receive the full amplification of which the stage is capable. The suppression of in-phase signals is of great advantage both in the elimination of hum from the output, and in the prevention of interaction between two separate amplifiers (Matthews, 1934). More recently the importance of this latter consideration when searching for synchronized motor units has been stressed by Lundervold (1949). Finally, it may be mentioned that as well as possessing inherent advantages a balanced input stage may always be converted to single-ended operation by connecting the grid of one side to earth.

In addition to the more general considerations such as those mentioned above the design of the first amplifying stage must receive careful consideration, since its performance effectively determines the overall response of the amplifier. As well as fixing the ratio between the gain of in-phase and out of phase signals, and initiating the uniform amplification of the frequencies in the pass band, the first stage is almost entirely responsible for the noise level of the amplifier. By noise is meant the small random signals occurring at the output of a high gain amplifier which are produced by the unpredictable electrical fluctuations occurring in the valves and

components of the first stage. The various causes of these fluctuations have been considered by MacDonald (1948) and the relative magnitude of the different fractions constituting the total noise by Harris (1948). Of the methods available for minimizing noise only two call for mention here. The first has been described above, and consists of reducing the band width of the amplifier to the minimum required for accurate recording. This is desirable, since the total noise is proportional to band width. The second consists of using only wire-wound resistors prior to the second amplifying stage. This is especially important in the case of current carrying resistors, since the passage of current through composition resistors produces electrical noise which is absent if wire-wound resistors are substituted.

Low Frequency Distortion

The small amplitude of the waveforms it is desired to record during electromyographic investigation necessitates the use of more than one stage of amplification. This fact introduces the problem of interstage coupling. As has been already stated above, direct coupling, with its attendant difficulties, is undesirable, and the alternative is resistance-capacity coupling. An enquiry must now be made into the possible undesirable effects of this form of interstage connection. Again it is convenient to consider the complex waveform to be recorded as consisting of a series of sine waves of appropriate amplitudes, frequencies and phase relationships. In the case of high frequency loss considered above, it was seen that the reactance of the stray capacity of the cable became less the higher the frequency, resulting in its ohmic value becoming low compared with the series resistance. In considering the problems of resistance-capacity coupling the position is reversed. The coupling condenser and the grid leak of the succeeding valve (fed from the anode load of the preceding stage) again form a potential divider across the signal source (V in), but in this case their relative positions are reversed. (See Diagram II.)

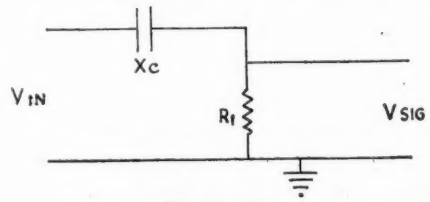

DIAGRAM II.

Thus as the frequency of the incoming sine waves becomes lower the reactance of the condenser (Xc) rises and the size of the signal (V sig) appearing across the resistance (R1) falls. Since the reactance of a condenser to a given frequency varies with its capacitance, the smaller the value of the condenser the greater will be the attenuation of low

frequencies. In addition to producing decreased amplitude of low frequency signals, inadequate interstage coupling is also responsible for changing the phase of these waves. It is to be noted that for a given capacitance its reactance and the phase shift it produces is always dependent on frequency, but in the case of interstage coupling the distortion produced only becomes obvious when the reactance of the condenser approaches the value of the series resistance. These considerations lead to the conclusion that the reactance of the coupling condenser used between two amplifying stages must be small compared with the associated grid resistor at the lowest component frequency of the complex waveforms it is desired to record. The product of the capacitance and resistance of an R.C. coupling, measured in microfarads and megohms respectively, is known as the time constant (in seconds) of the coupling. It is useful to remember that in order to pass a given frequency with only approximately 1 per cent. loss in amplitude the time constant of the coupling should be equal to the periodic time of the waves. The effects of a single short time constant coupling on the reproduction of a rectangular wave, diphasic wave, and a complex potential are shown in Fig. 7.

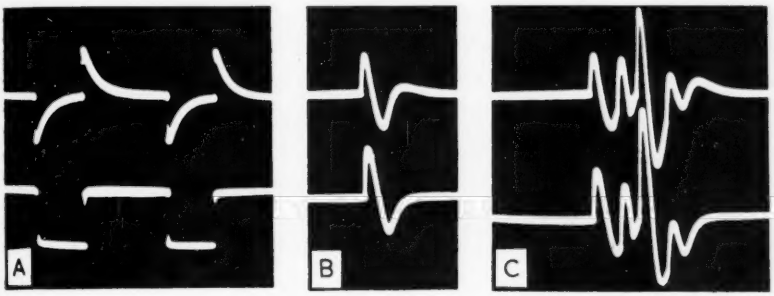

FIG. 7.

Effect of a single R.C. coupling (time constant = 0·001 sec. approx.) on (*a*) rectangular wave, (*b*) diphasic potential, (*c*) polyphasic potential. Note triphasic nature of the output waveform in (*b*).

It is seen that a time constant of 0·001 sec. appreciably distorts the records. In an amplifier which contains more than one interstage connection the effects of the successive couplings are cumulative, both in respect of the attenuation and phase shift of low frequencies. It is thus necessary to arrange that the overall time constant of the amplifier, obtained by taking the reciprocal of the sum of the reciprocals of the several interstage time constants, is long compared with the duration of the lowest frequency waveform to be examined, and that the total phase shift of the lowest frequency component, obtained by summating the individual displacements in each R.C. coupling, is tolerable. The alterations produced in the standard rectangular, diphasic and complex

waves by introducing a second time constant of the same value as the first, is illustrated in Fig. 8. In considering the overall time constant of an amplifier a complication is added by the fact that the final value is influenced by other capacitative components such as by-pass condensers. However, their influence on the final figure is usually considerably less than that exercised by the actual interstage coupling, and so will not be considered further.

Finally, in dealing with resistance-capacity coupling, "blocking" must be mentioned. It might appear from the considerations above that by making the time constant of each interstage connection very long, for

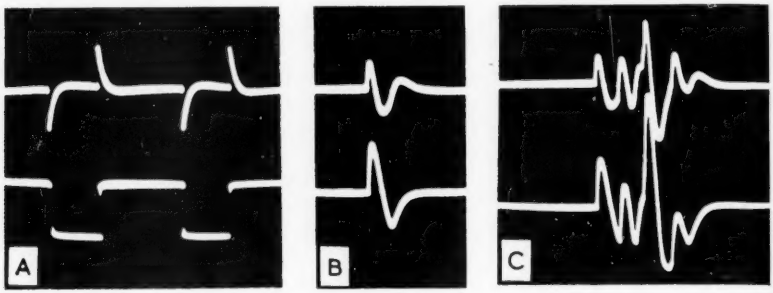

FIG. 8.
As in Fig. 7, but with the addition of a second R.C. coupling of the same value time constant.

example 4 seconds, low frequency distortion would be minimized without any attendant disadvantages. This is not the case. With a condenser-coupled amplifier any overloading, that is any excessive signal applied to the input, may result in an undesirable flow of current in the grid circuit of one of the amplifier stages which in turn causes a charging of the related coupling condenser. This accumulated charge then has to leak away via the associated grid leak, and during this time the amplifier is unusable. Obviously the longer the time constants employed in the couplings the longer will be the duration of the block, and the more inconvenient the delay becomes.

Summary

1. An accurate method of recording is necessary in electromyography if results obtained from one amplifier are to be compared with those from another or with descriptions in the literature, without lengthy calculations.

2. In investigating this problem, complex wave-forms may with advantage be considered as a summated series of sinusoidal waves of different amplitudes, frequencies and phase relationships.

3. The overall performance of the amplifier is determined mainly by the first amplifying stage.

4. The main causes of distortion in amplifiers are low and high frequency losses.

5. High frequency loss may be minimized by the use of the cathode follower and double screened cables.

6. Low frequency loss is determined by the overall time constant of the amplifier.

Acknowledgments

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EXPERIENCES WITH CORTISONE AND ACTH

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THE discovery of the effects of Cortisone and ACTH on the disease process of rheumatoid arthritis has led to the phenomenon of the swing of the pendulum with which we are so familiar when any new medical discovery is made. Throughout the original paper by Hench and his associates in which they announced their findings we read a note of conservatism, caution and warning against undue optimism. But immediately the announcement was made a surging wave of enthusiasm arose which appeared likely to swamp Hench's caution and to carry the enthusiasts to heights of optimism far beyond what was justified. It was said that the problem of rheumatoid arthritis was solved, and an eminent specialist in physical medicine said at that time that it looked as though physical medicine would no longer have any part to play in the treatment of rheumatoid arthritis but that any rate we could " clean up the ashes of the disease in those affected persons who had developed the disease previous to the discovery of Cortisone ". This surprising statement has been completely disproved, and the pendulum has swung back and probably will continue to swing.

Writing in the *Journal of the American Medical Association*, Margolis and Caplan (1951) reviewed the effect of ACTH in rheumatoid arthritis and concluded that measures such as physiotherapy have by no means lost their value now that these new potent preparations have arrived. Following this, Boland (1951) wrote very cautiously on the effects of long-term administration of these preparations and made it quite clear that the answer to the problem of rheumatoid arthritis had by no means been found. An editorial in the *British Medical Journal* (1951) on the ACTH Conference in Harrogate entitled " Judgment on ACTH " stated that " physiotherapy still remains of prime importance in treating rheumatoid arthritis ". More recently Slocumb (1951), discussing rheumatoid arthritis in the wards of the London Hospital, said that he still considered rest and physiotherapy to be the first lines of attack on this disease and that this should always be tried before one considers the possible use of gold, Cortisone or ACTH, all of which may possibly be dangerous. The caution and wisdom expressed in the original paper of Hench and his colleagues merits its repeated study by those interested in the problem of rheumatoid arthritis.

There is now a considerable amount of clinical experience of the use of Cortisone and ACTH in this country. In spite of this and the acceptance

of the fact that these preparations do profoundly affect the rheumatoid process, we have learnt no more about the aetiology of this condition. These preparations have very marked effects in a large variety of diseases which seem to have no connection with each other, and the speculation on the aetiology of rheumatoid arthritis continues unabated. New treatments of rheumatoid arthritis, some of which are even claimed to be curative, are advocated in the medical journals two or three times each year. Almost without exception these fall by the wayside and are forgotten. But it is of profound importance that workers in this field should realize that many patients suffering from rheumatoid arthritis who are treated with a great diversity of therapeutic procedures are apparently greatly benefited. In a series of patients treated in the London Hospital with rest in bed, active non-weight-bearing exercises and physiotherapy alone, good objective and subjective results were obtained in three-quarters of the sufferers. It is possible that if any other forms of so-called specific therapy had been exhibited to these patients, such methods might have been regarded as responsible for the improvement. But when one compares patients treated in this way with the great majority of those treated with Cortisone or ACTH one cannot escape the fact that the response to these preparations is much more rapid and profound. The immediate clinical response to a short period of treatment with Cortisone or ACTH is such that no other method of treatment can stand comparison with it, and thus the exhibition of these preparations and the results obtained can be regarded as a yardstick of possible improvement under therapy.

Clinical Experiences

A small series of twenty-two patients has been observed under treatment with Cortisone or ACTH. Of these, eleven received one short course lasting from a week to ten days, four received more than one short course, and the remaining seven have had Cortisone for three months or more. While individual needs vary and therefore dosage cannot be standardized, it has been found that on the whole 100 mgm. of Cortisone divided into four doses of 25 mgm. constitutes a sound basic dose. In whatever form the preparation is made up, that is whether for intramuscular injection or in tablets for oral administration, it can be taken by mouth; the fluid preparation can easily be taken in milk or orange juice. In no case has it been found necessary to start Cortisone administration by injection and thus no Cortisone abscesses which others have found troublesome and difficult to treat, have been met. On the other hand, ACTH must be given intramuscularly in doses of approximately 20 mgm. every six hours.

In all twenty-two patients there has been a rapid response to the administration. In all those patients in whom administration had to be

stopped owing to lack of further supplies or severe side effects, there has been a total or partial relapse. Within forty-eight hours of the first dose all patients experienced a vivid relief of symptoms and an unusual sense of well-being. Movement which has hitherto been painful has become far less so, and range of movement has been greatly improved even in advanced cases. But in all patients to whom the preparation could no longer be given this happy state of affairs has ceased. It is, therefore, during the period of administration that all possible steps to improve joint and muscle function must be taken. It is at this time that active non-weight-bearing exercises and correction of deformity by splinting can be intensively carried out. Thus Cortisone can be used to enable the proven benefits of physiotherapy to be used to their full. The extent to which patients will relapse after treatment ceases, depends on the amount of improvement in muscle power and joint function that has been obtained, but it also depends very largely on the psychological effect of improvement followed by relapse on the individual patient. Thus two women sufferers with a comparable degree of rheumatoid arthritis were each presented with one gramme of Cortisone by interested friends in America. Each therefrom enjoyed ten days of relief from symptoms and of well-being. But when supplies were exhausted, one responded with deep despair and self-pity, reducing herself to a condition as bad as before, while the other maintained much of her improvement and decided that the arthritic's outlook was now much brighter, as there exist preparations of immense potency which one day will be available to all and will be safely administered.

All four patients who received more than one short course of administration relapsed to some extent when supplies were withheld. Of these, three experienced considerable recrudescence of activity of the disease process, while one seemed to have gone into a great degree of quiescence and has remained very much better for nine months and has been able to perform activities which had been impossible for two years.

Long-Term Administration

Seven patients have been able to obtain private supplies of Cortisone sufficient to enable them to keep taking it for three months or more. One of these had been bedridden for two years, two more ambulant but moderately severely afflicted, four were comparatively mildly afflicted. Four were men, three women.

In all cases there was a good rapid response to 100 mgm. a day taken orally. In all cases intensive physiotherapy was instituted with gratifying results. The most severely afflicted patient, a man who had been bedridden for two years, drove his car (albeit against advice) after three months of treatment. Three patients reported activity of arthritis while under

treatment. In one case this was undoubtedly due to cutting down the dosage of Cortisone in order to see if a lower maintenance dose was possible; restoration of 100 mgm. a day reversed the relapse. The other two patients gave a valuable object lesson. Both, one man and one woman, were moderately severely afflicted, but were restless, hard-working and energetic in character; both were found to have grossly overtaxed their strength and damaged joints under the analgesic effect of Cortisone. It is essential that patients such as these should understand that there is some irreversible joint damage and that unwarranted weight-bearing activity will inevitably result in traumatic arthritis. The patients must be very firmly guided and instructed about this. One patient had a very salutary object lesson when she forgot to take her tablets away with her for a week-end. She soon realized that she was not cured and could not afford to take liberties. Many efforts have been made to find adjuvants to the action of Cortisone which would enable smaller doses to be taken. Thus efforts have been made to combine chrysotherapy with Cortisone, and Kersley (1951) and his colleagues have written on the simultaneous use of insulin. In an annotation in the *Lancet* (1951) it was suggested that the simultaneous administration of para-amino benzoic acid would allow the dose of Cortisone to be cut by half. This was tried in one patient with negative results, for the patient relapsed rapidly.

Most of these long-term patients have to take 100 mgm. daily, but one has successfully adopted a maintenance dose of 75 mgm. a day. They sometimes find it tempting to take an extra 25 mgm. tablet to "give themselves a boost" for a special occasion. Such unwarranted manipulation of dosage outside medical advice must be firmly discouraged. It has not been found possible to reduce the dose below 75 mgm. a day. Attempts to find a maintenance dose below this have always been followed by relapse and in this series the experience has been that to give too low dosage is merely to waste a valuable and expensive drug.

Response of Patients

For a long time attempts have been made to ascertain the best type of patient to treat with our limited supplies of Cortisone and ACTH. Clinical evaluations have been made, and similarly laboratory investigations, such as the extent of eosinophil fall on test doses, have been called in in an attempt to allow an estimate to be made of how the patient will respond. Such attempts at prognosis have proved disappointing. The acute early case of rheumatoid arthritis normally responds well but relapses with equal ease. But while it has been thought that the patient afflicted with severe chronic rheumatoid arthritis might be the least suitable for treatment, in two cases in this series this has not proved to be so. For two patients who were able to obtain long-term treatment

responded remarkably well and ceased to be wholly dependent. It was realized at the outset that there was much irreversible change in the joints, but the relief of pain afforded to the patients and their own unremitting efforts produced a very gratifying result. It is now generally agreed that the rationale of the administration of Cortisone is to tide the patient over till a natural remission of the activity of the arthritis occurs; this opinion has been borne out in this series.

Side Effects

The experience with side effects in this series must be regarded as unusual and not of particular guiding value. With the American preparations of both Cortisone and ACTH, side effects were minimal and consisted in rounding of the face in two patients, a slightly pathological euphoria in one patient and a transient diabetes in another. The rounding of the face occurred in long-term patients and caused no anxiety whatsoever. None of the more serious complications were met. But two of the short-term patients obtained their own supplies of a European preparation of ACTH which appeared to be downright poisonous. One patient went into mania for which she had to be sedated, and the sedation resulted in broncho-pneumonia; had it not been for antibiotics the outcome would certainly have been fatal. Nevertheless, when finally the patient recovered from both psychosis and pneumonia there was some definite objective improvement in the arthritis. The second patient responded in a way suggestive of heavy posterior pituitary lobe contamination in the ACTH, for she developed violent vasomotor reactions and anuria, from which she fortunately recovered. It appears, then, that only the products of reputable and experienced firms can safely be used and that there is a danger in hurried efforts to manufacture a popular drug without due experience and care.

Pregnancy

An interesting observation on pregnancy was made in two patients, one of whom, as she never as yet has received Cortisone, is not included in the series. A young woman suffering from rheumatoid arthritis experienced great relief during pregnancy and the remission was maintained for nine months after delivery, when she relapsed. She was very unhappy and made arrangements to obtain Cortisone herself. When finally it arrived and before she had taken any she reported that she was in happy quiescence again and that she thought, therefore, that she must be pregnant—a supposition which proved correct. She has not yet had to take Cortisone. The second patient, a woman of 38 with one child, who had been born prior to the onset of rheumatoid arthritis, was taking Cortisone which she had obtained herself. One day she reported amenorrhoea and asked whether this was due to Cortisone or pregnancy. She

was advised to stop Cortisone and see what happened. Ten days later she was able to report only a trivial and transient relapse; and it was therefore thought that she must be pregnant, which proved to be the case.

Summary and Conclusions

Cortisone and ACTH are not alone the answer to the problem of rheumatoid arthritis, but they prove a valuable therapeutic weapon in the management of the arthritic patient. The methods employed in physical medicine have an enhanced, not a reduced, value since these preparations have been discovered. The immediate clinical response of patients to Cortisone or ACTH is far greater than that to other so-called therapeutic measures.

Of a small series of patients, all responded favourably to Cortisone or ACTH. All were treated systematically by physical means while taking these preparations. When supplies run out or are withheld some degree of relapse is inevitable unless natural quiescence has occurred meanwhile. Long-term administration is being successfully carried out in seven patients.

There is a great need to guard against over-activity and exercise, before the patient's muscles have been sufficiently strengthened, otherwise traumatic arthritis will supervene. With Cortisone and ACTH produced by reputable and experienced manufacturers, side effects did not cause any serious problems; on the other hand, dangerous effects were noted in patients treated with the products of less experienced manufacturers. Two patients who became pregnant while suffering from rheumatoid arthritis provided an interesting comparison between the effects of Cortisone and pregnancy on the disease process.

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THE EFFECT OF ULTRA-VIOLET LIGHT ON THE SKIN AND HAEMOGLOBIN OF PATIENTS TREATED WITH IRON

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KOVACS (1937) and Barer and Fowler (1945) found that irradiation with ultra-violet light had a haemopoietic effect. Laurens (1933) quoted 31 authors since 1893, 18 of whom reported an increase, 2 a decrease, and 11 no change in the red blood count and/or haemoglobin concentration after exposure to ultra-violet light. Ostermann (1926) considered that U.V.L. enhanced the haemopoietic activity of iron. Eder (1935) claimed that iron increased the tolerance of the skin to sunlight, but Furniss (1931) and Kovacs (1949) stated that the administration of iron to patients led to an increase in the sensitivity of the skin to U.V.L.

Clearly, there is considerable divergence of opinion on these matters. An experiment was designed, therefore, to attempt to throw further light upon the subject.

Plan of the Experiment

A series of patients, referred to the Department of Physical Medicine for irradiation with U.V.L., was divided at random into four groups, each of which was irradiated for six weeks as described below. Groups I and II received infra-red irradiation, and Groups III and IV ultra-violet light. Groups II and IV were given Fersolate, gr. 6 three times daily in addition; the administration of iron was continued for ten weeks. Haemoglobin determinations were made on each patient at the first attendance, after the six-weeks course of irradiation, and again four weeks later.

Methods

(i) *Irradiation*

A non-luminous infra-red lamp (Sollux, Hanovia) was used. The front and back of the body were exposed for three minutes each at the first exposure. The time was increased by two minutes at each subsequent exposure. These were made twice weekly to a total of twelve.

The source of U.V.L. was a large frame carbon-arc lamp (Watson) on a D.C. circuit operating at 32 amperes. The carbons were tungsten cored (Gamma carbon. The Ship Carbon Co.). At a distance of 36 inches, this lamp usually produced a first degree sunburn response in 4 to 6 minutes. The exposure time (E) required to produce perceptible redness

in the skin within a few hours of irradiation and subsiding in 24 hours, was determined to the nearest minute for each patient. The test site used was the inner side of the arm (cf. Kovacs, 1949). An exposure, E, was given to the front and back of the body separately on the first occasion and was increased by $\frac{1}{2}$E on each subsequent occasion. Twice weekly exposures were given to a total of twelve.

(ii) *Determination of haemoglobin*

All blood samples were taken by the same person from the finger tip and the amount of haemoglobin determined by the alkaline haematin method with the aid of a Tinsley photometer. The Gibbs and Harrison standard was so adjusted that 100 per cent. corresponded to 14·8 g. of haemoglobin per 100 ml. blood.

(iii) *Clinical material*

The work was done on out-patients who lived in the neighbourhood. 116 patients were investigated, and of these 75 completed the experiment. The clinical diagnoses made are shown in Table I, together with their distribution between the four experimental groups.

TABLE I

Diagnosis.	Group				
	I.	II.	III.	IV.	Totals.
A Psychogenic rheumatism	7	5	4	6	22
B Osteoarthritis (hips, knees, etc.) ..	5	1	6	3	15
C Rheumatoid arthritis	1	5	3	1	10
D Brachial neuralgia	3	1	0	3	7
E Fibrositis	0	1	1	2	4
F Miscellaneous (obesity, P.I.D., recurrent boils, etc.)	2	5	4	6	17
Totals	18	18	15	21	75

92 per cent. of the patients were women, 78 per cent. over the age of 40 and 56 per cent. over the age of 50. The 41 patients who have been excluded from the analysis either missed three successive treatments or did not take their iron regularly. The patients were asked to take no other medicines during the course of the experiment, but occasional doses of Tab. Cod. Co., aspirin, and phenobarbitone had to be allowed.

Results

The results of the determination of haemoglobin on first attendance, at the end of the course of " ray treatment ", and one month later are shown in Table II. The mean percentages of haemoglobin and the standard deviation from the means are included in the Table.

TABLE II

HAEMOGLOBIN CONCENTRATION OF PATIENTS TREATED WITH IRON, U.V.L. AND INFRA-RED RAYS

	Group I. (Infra-red alone.)				Group II. (Iron+infra-red.)				Group III. (U.V.L. alone.)				Group IV. (Iron+U.V.L.)			
		1	2	3		1	2	3		1	2	3		1	2	3
1	A	93	96	92	D	65	93	92	C	93	96	94	C	81	83	85
2	B	88	86	84	A	90	88	83	A	85	85	85	C	103	102	105
3	C	59	60	65	E	80	77	90	C	88	85	84	B	93	88	83
4	D	88	85	93	C	71	78	80	F	93	92	83	F	79	80	77
5	D	62	68	69	A	80	81	81	F	76	79	80	F	92	89	92
6	A	111	81	76	C	74	74	70	B	76	73	79	F	73	83	88
7	F	90	88	86	C	94	80	83	C	74	92	93	B	92	86	90
8	B	81	83	80	C	88	83	89	B	90	92	86	F	85	85	85
9	A	83	80	86	A	83	88	88	A	89	85	88	A	94	70	96
10	A	76	81	80	F	89	92	93	A	83	86	85	A	81	80	89
11	F	76	74	71	B	83	89	92	B	74	80	84	D	88	80	85
12	B	85	94	80	F	86	93	89	B	102	96	100	E	85	80	88
13	B	81	83	86	F	102	76	94	B	85	96	93	B	80	109	88
14	D	85	70	71	A	85	85	86	E	86	99	92	D	78	77	74
15	A	62	63	74	C	97	104	99	F	103	89	99	F	88	94	92
16	A	90	85	90	F	74	83	85	F	85	83	85	A	77	83	88
17	A	102	99	97	A	81	80	84	A	78	70	70	F	76	76	85
18	B	99	100	106	F	80	85	81	B	85	79	92	A	93	93	99
19													A	85	96	88
20													D	85	93	89
21													A	76	81	71
Mean		83·9	82·0	82·5		83·4	84·9	86·7		85·8	86·8	86·8		84·9	86·1	87·5
± S.D.		13·5	11·3	10·5		8·6	7·3	6·5		8·0	7·6	7·2		7·4	9·6	7·6

Hb concentrations in percentages. 100% = 14·8 g. Hb/100 ml. blood.
Column 1 = Initial Hb value.
2 = The end of the irradiation.
3 = One month later.
A, B, C, etc., refer to the diagnostic groups of individual patients (cf. Table I).

It will be seen that there was no significant difference between the groups as far as the initial concentration of haemoglobin is concerned. The mean value for the 75 patients is 85·1 per cent. or 12·6 g. per 100 ml. blood. Table II shows that there is no evidence that iron, U.V.L., or the two combined have any haemopoietic activity in this group of patients as a whole, either during irradiation, or in the post-irradiation period.

If the whole 116 patients are considered, the mean haemoglobin is 84·2 per cent. Of these 116, 13 patients had rheumatoid arthritis, 5 with haemoglobin values below 80 per cent. If these 13 cases are excluded, the mean haemoglobin concentration is 84·7 per cent. Out of this last group of 103 patients, 25·2 per cent. had haemoglobin values below 80 per cent., and 6·8 per cent. below 70 per cent.

Iron and Skin Photosensitivity

Only 8 of the 116 patients had skin lesions sufficient to warrant attention. These were distributed amongst the four groups as shown in

Table III. None of these lesions could be attributed to the administration of iron and U.V.L.

TABLE III

Skin Lesion.	Group			
	I.	II.	III.	IV.
Herpes zoster	—	—	1	
Psoriatic exacerbation	—	1	—	—
Prurigo	1	—	—	—
Non-specific erythema	—	1	—	—
Facial erythema	—	—	—	1
" Excessive " sunburn response	—	—	3	—

The case of herpes appeared after the first treatment with U.V.L. An exacerbation of psoriasis occurred at the end of the course of infra-red rays, and followed a normal course in this patient. Prurigo was on the forearms and appeared during the infra-red treatment and lasted for nearly three weeks. The non-specific erythema was on the trunk and lasted 3-4 days. The facial erythema appeared after the third exposure to U.V.L. and lasted at least eight weeks after the course of U.V.L. ended.

The " excessive " responses were probably connected with the fact that the skin of the back was more sensitive to U.V.L. than the skin of the arm. They all occurred after the first irradiation.

The following additional observations were made:

(i) Four patients continued to take Fersolate for another six weeks and received a second course of U.V.L. without mishap.

(ii) The unit of exposure (E) was determined on the backs of four other patients. Each was given a test dose (20 mg.) of Ferrivenin (Benger) intravenously. Five days later each was given Ferrivenin (100 mg.) and, after 30 minutes, the front and the back of the body was exposed to U.V.L. for time E. No abnormal reactions were seen.

(iii) A patient, aged 77, with a history of haemochromatosis for at least 19 years, was exposed on the inner side of the arm to a Kromayer lamp at contact range for 2, 8, and 12 seconds. The response of the skin was normal.

Discussion

The patients who formed the basis of this investigation were not selected because their blood haemoglobin concentrations were low. They represented 116 consecutive patients referred to the Department for " ray treatment ". Similar levels of haemoglobin in apparently normal groups have been reported before (Davidson, Fullerton, and Campbell, 1935; Fowler and Barer, 1941; Marshall, 1942-3). In contrast, however, to Fowler and Barer (1941) and Barer and Fowler (1945), there was no significant improvement either with adequate doses of iron given orally

or with ultra-violet irradiation. The results also do not lend support to the conclusions of Ostermann (1926), who claims that iron and U.V.L. in combination are effective where iron alone fails.

The discrepancy in results may be due to differences in the subjects investigated or to some experimental point that cannot be identified from the details provided by the publications of the above authors. With the dose of U.V.L. given in this series of experiments, no effect was observed on the blood haemoglobin concentration.

There is no evidence in this series that the skin of patients receiving iron is in any way sensitized to the action of U.V.L. (cf. Kovacs, 1949). Not only is evidence lacking from the long-term experiments (cf. Table II), but even when iron was given intravenously no sensitization of the skin to U.V.L. occurred. No reports of instances of photosensitivity arising spontaneously in patients receiving iron have been found in the literature. It is possible that the view that iron sensitizes the skin to U.V.L. has arisen from a misconception of the results obtained by Neuberg and Galambos (1913).

Summary

1. In a group of patients referred to "ray treatment", iron given by mouth, U.V.L., or iron and U.V.L. given together had no effect in increasing the blood haemoglobin concentration although, on the average, this was only 12·6 g./100 ml. blood.

2. No evidence was obtained that iron sensitizes the skin to the action of U.V.L.

We are indebted to Dr. W. S. Tegner for allowing us to investigate his patients; to Miss S. G. Orme and her Staff for their co-operation; and to Dr. H. B. May for providing facilities for large numbers of haemoglobin determinations.

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SUGGESTIONS TO AUTHORS

" ANY one who wishes to become a good writer should endeavour, before he allows himself to be tempted by the more showy qualities, to be direct, simple, brief, vigorous, and lucid." (Fowler and Fowler, 1949.) There could be no better advice than this to writers of scientific papers, and no better example of how the opening sentence of a paper should read.

The Editors of *The Journal of Physiology* amplify this advice in their " Suggestions to Authors ". " Authors are asked to aim at writing papers as briefly as possible. Brevity, as a rule, accelerates publication, reduces editorial work and the cost of printing, and, lastly, lightens the burden of the reader. Errors from excessive brevity are more easily repaired than those from prolixity. It is important to remember that a reader's impression of a paper is often influenced by its literary style, and in his own interests the author should take pains about his style in order to convey his meaning to his readers. Care should be taken in the choice of appropriate words and their place in the sentence, as well as in the sequence and linkage of sentences." The Editors of *The Journal of Physiology* recommend A. P. Herbert's *What a Word* and Fowler's *Modern English Usage*. To these may be added Sir William Gower's recently published *Plain Words* and *The A.B.C. of Plain Words* which make absorbing as well as instructive reading.

The following sequence should be observed in papers presented for publication:

1. Introduction.
2. Methods of enquiry, observation or experiment.
3. Results.
4. Discussion.
5. Summary.
6. Acknowledgments.
7. References.

Some of these headings need elaboration. In the introduction the author should state in the simplest possible terms the purpose of his paper. In the introduction also, relevant literature may be reviewed, but only if it has a direct bearing on the subject of the paper. As a rule results are best given in words; large tables of figures from which the reader must draw his own conclusions must be avoided. Diagrams and graphs should be fully explained in the legends underneath, or in the text. In the discussion, the author should draw conclusions from his own observations and balance them against those of others. Here brevity and clarity are all-important; authors must guard against confused thought and inconsequent reasoning which too often characterize this part

of a medical paper. A concise but comprehensive summary is necessary in every case. Authors must remember that many people read the summary before any other part of the paper and judge therefrom whether the paper is worth reading. Others read the summary and nothing else. Finally, summaries may be reproduced as they stand in journals which publish abstracts. The following is an example of how a summary should *not* read:

1. The treatment of varicose ulcers by physical methods is described.
2. The results of treatment are discussed.

This is nothing more than an elaboration of the title; it gives the reader no indication of what is in the paper, and is therefore unlikely to induce further study. On the other hand, the paper would commend itself to any one interested in varicose ulcers if its summary read:

1. 481 out-patients with chronic varicose ulcers have been treated by a combination of massage, bandaging and exercises.
2. Of the 405 patients under continuous observation, 353 were discharged cured. 42 (12·2 per cent.) relapsed within four years.

Finally, the author should include only such references as are relevant to his thesis. A long list may be necessary in a critical review of published work, but except in these circumstances " wanton inflation of a reference list deceives nobody and irritates readers who recognize it for what it is ". (Howie, 1951.) References often give editors more trouble than anything else. It is most important that authors should verify personally the accuracy of every reference before submitting a paper for publication.

Detail

(*a*) *General*

Papers sent for publication must be typewritten on one side of the paper only, with double spacing and wide margins, on sheets of uniform size, e.g. all foolscap or all quarto. They should be carefully corrected and as nearly ready for the press as possible before submission. Insertions should be few and legible. Papers should be packed flat. Italics in the text (which should be few) are indicated by a single line under the words to be italicized.

(*b*) *Title*

The title should be concise, and typed on a separate sheet which should also bear the names of the authors, and that of the Department or Unit where the work has been carried out. If there are several authors their names should be in alphabetical order. A short title of not more than four or five words is required for the index and the top of the right hand page of the journal.

(*c*) *Headings in the text*

The following headings or subheadings may be used in the ANNALS OF PHYSICAL MEDICINE.

1.	SECTION III	(Capital and small capitals)
2.	**Results**	(Bold)
3.	(*a*) *Microwave apparatus*	(Italics, full out)
4.	(1) *Lumbar lordosis.* This is . . .	(Italics, indented)

The usual headings are (2) bold type and (3) italics full out. Recent numbers of the Annals should be consulted for examples of headings. No full stop is required after headings except for (4).

(*d*) *Tables and illustrations*

Tables are expensive to print and should be as few as possible ; they should be typed on separate numbered sheets. Illustrations are of two kinds: (1) line drawings or tracings, and (2) photographs. Drawings and tracings should be in Indian ink on Bristol board, and about twice as large as their intended final size. It is generally best to leave the lettering on them in pencil, or typewritten on a separate sheet. Photographs should be on glossy paper and also larger than intended for publication. Radiographs are more acceptable as prints than as negatives. Photographic illustrations and radiographs should be unmounted with their numbers and the author's name marked in pencil on the back. Graphs should be on blue (not red or grey) feint lined paper or on Bristol board.

Legends and captions should be typewritten on a separate sheet of the manuscript. Figures should be referred to in the text in Arabic numerals, e.g. Fig. 3; Plates and Tables should bear Roman numerals, e.g. Plate V, Table IV.

(*e*) *References*

The Harvard system of references will be used. References must be given in alphabetical order at the end of the paper. They should be arranged as follows:

1. Author(s) name(s) followed by initial(s).
2. Year of publication in brackets. If several papers by the same author in one year are quoted, *a*, *b*, *c*, etc., are placed after the year of publication.
3. Title of journal, abbreviated in accordance with the *World List of Scientific Periodicals*, and underlined to indicate italics.
4. Volume number in arabic numerals underlined with a wavy line to indicate black type, *without* prefix " vol.".

5. The number of the first page in arabic numerals, *without* prefix "p.".
6. When reference is made to a book, the title should be underlined; the edition (ed.), page (p. or pp.) should be given, followed by the place of publication and publisher.

The references will then read as follows:

BAUWENS, P. (1948) *Proc. R. Soc. Med.* **41**, 291.
COOK, H. F. (1951*a*) *Brit. J. app. Phys.* **2**, 295.
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KOVACS, R. (1949) *Electrotherapy and Light Therapy*. 6th ed. p. 619. London: Kimpton.

In the text, references are made by giving in brackets the name of the author and the year of publication, e.g. (Bauwens, 1948), except when the author's name is part of the sentence, e.g. "Bauwens (1948) showed that . . .". When a paper written by two authors is quoted, both names are given, e.g. Curwen and Scott (1952). If there are more than two authors, all names should be given when quoted for the first time, and thereafter the first name only, adding "*et al.*".

(*f*) *Footnotes*

Footnotes are expensive and should be avoided unless really necessary.

(*g*) *Proofs*

Slip proofs are sent to authors for correction of printer's errors; not for alterations and additions, since papers with their illustrations and diagrams should virtually be ready for press before submission. Authors making extensive alterations may be asked to bear the cost thereof.

Authors must pay attention to checking references and to filling in page references where necessary. If, for example, a passage on page 1 of the slip proof is referred to on page 3 of the slip proof, the passage on page 1 should have a line drawn down the side of it and a large capital A inserted in the margin; then on page 3 where the proof reads "see page 00", a note should be written in the margin "see A, page 1 of slip". Succeeding references should be indicated by letters B, C, etc.

Paged proofs are not as a rule sent to authors.

Summary

1. Papers submitted to ANNALS OF PHYSICAL MEDICINE should follow this sequence: (1) Introduction; (2) Methods of enquiry, observation or experiment; (3) Results; (4) Discussion; (5) Summary; (6) Acknowledgments; (7) References.

2. In the discussion brevity and clarity are all-important.

3. The summary is a necessary part of every paper; many judge from it whether the paper is worth reading. It may be reproduced in journals which publish abstracts.

4. In order to assist the editor and facilitate publication, papers on submission should be as nearly ready for publication as is possible; references accurately and correctly set out in accordance with the Harvard system; diagrams and illustrations prepared so that they will reproduce clearly and not involve unnecessary expense.

Acknowledgments

In the preparation of the above notes the author has drawn freely from " Suggestions to Authors " from *The Journal of Physiology* (1945), and also from " Notes on the preparation of papers to be communicated to The Royal Society ". The reader is referred to these for further details.

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THE EDITOR

THE INTERNATIONAL CONGRESS OF PHYSICAL MEDICINE (1952)

DETAILS of the scientific programme of the International Congress of Physical Medicine are outlined in the following pages. With the exception of the demonstration of physical education at Aldershot on the afternoon of Tuesday, July 15th, 1952, all scientific sessions will take place at King's College, The Strand, London. The programme is subject to final revision.

Monday, July 14th, 1952

Afternoon—Opening of the scientific and historical exhibitions by the President, followed by Review of PHYSICAL MEDICINE IN THE PAST DECADE

1. F. D. HOWITT (G.B.)
2. F. H. KRUSEN (U.S.A.)
3. S. CLEMMESEN (Denmark)
4. V. E. KLARE (Austria)

Tuesday, July 15th, 1952

Morning—Symposium on PHYSICAL EDUCATION

5. E. GRANDJEAN (Switzerland)
   Problems of physical education in adolescence.
6. J. H. KUITERT (U.S.A.)
   The problem of physical defects in recruits to the armed forces.

Afternoon—Demonstration at Aldershot

Introductory paper by A. H. GEM, followed by demonstrations by schoolchildren, organized under the aegis of the Research Board for the Correlation of Medical Science and Physical Education.
Introductory talk on PULHEEMS by J. B. M. MILNE.
Demonstration of Basic Tables and Recruits Tests.
Talk and demonstration of Conditioning Courses by J. B. M. MILNE.
Standard Tests and Battle P.T. demonstrations.

Wednesday, July 16th, 1952

Morning—Symposium on REHABILITATION AND RESETTLEMENT

7. HOWARD A. RUSK (U.S.A.)
   The rehabilitation of the hemiplegic.
8. P. HOUSSA (Belgium)
   Post-traumatic rehabilitation.
9. F. S. COOKSEY (G.B.)
   Vocational resettlement in Great Britain.

Forum: *Chairman:* H. Balme (G.B.). *Members:* R. L. Bennett (U.S.A.), F. S. Cooksey (G.B.), P. Houssa (Belgium), C. J. S. O'Malley (G.B.), Howard A. Rusk (U.S.A.), W. Zeiter (U.S.A.).

Afternoon—Proffered papers on various aspects of rehabilitation

10. H. H. KESSLER (U.S.A.)
    Rehabilitation of the severely disabled.
11. T. M. LING (G.B.)
    Psycho-social aspects of rehabilitation.
12. R. L. BENNETT (U.S.A.)
    Supportive and assistive apparatus in convalescent poliomyelitis.
13. H. I. WEISER (Israel)
    Convalescence from poliomyelitis in toddlers.
14. M. E. KNAPP (U.S.A.)
    Results of treatment of acute poliomyelitis at the Kenny Institute.
15. G. GINGRAS (Canada)
    Rehabilitation pilot centre in Montreal.
16. A. J. MARTIN (G.B.)
    Resettlement of the disabled from a general hospital.
17. A. B. C. KNUDSON (U.S.A.)
    Physical medicine and rehabilitation in the Veterans Administration: with special reference to the severely disabled, the chronically ill and the ageing.
18. L. COSIN (G.B.)
    Rehabilitation of the aged.
19. E. F. C. WADGE (G.B.)
    Some practical aspects of geriatric rehabilitation.
20. M. O'DONNELL (Eire)
    The modern approach to the treatment of infantile cerebral palsy.
21. V. A. PORSMAN (Denmark)
    Physical medicine and rehabilitation in a geriatric department.
22. C. B. WYNN PARRY (G.B.)
    Resettlement and rehabilitation in the Royal Air Force.
23. F. J. KOTTKE (U.S.A.)
    Studies on vasomotor activity in the feet following acute anterior poliomyelitis.
24. G. H. FISK (Canada)
    The physical treatment of the hemiplegic.

Thursday, July 17th, 1952

Morning—Symposium on THE MANAGEMENT OF THE CHRONIC RHEUMATIC AND OTHER DISORDERS OF THE LOCOMOTOR SYSTEM

25. Sir HENRY COHEN (G.B.)
    The place of endocrines in the management of chronic rheumatic disorders.
26. L. J. MICHOTTE (Belgium)
    Les douleurs du bas du dos.
27. H. A. BURT, W. D. FLETCHER, D. A. KININMONTH, S. MATTINGLY (G.B.)
    The management of the painful shoulder.

Forum: *Chairman:* F. D. Howitt (G.B.). *Members:* H. A. Burt (G.B.), Sir Henry Cohen (G.B.), L. J. Michotte (Belgium), W. S. Tegner (G.B.), K. M. Walthard (Switzerland).

Afternoon—Proffered papers on the treatment of the chronic rheumatic and other disorders of the locomotor system

28. H. PETTY (G.B.)
    Modern orthopaedic aspects of rheumatoid arthritis.
29. F. BACH (G.B.)
    The use of cortisone as an aid to physical treatment in the rheumatic disorders.
30. W. A. FELL (G.B.)
    Treatment of osteoarthritis of the hip by procaine injection.
31. J. MICHEZ (Belgium)
    Le traitement physiothérapique de la polyarthrite chronique évolutive.
32. E. W. LOWMAN (U.S.A.)
    Rehabilitation of the chronic rheumatoid arthritis derelict.
33. V. R. OTT (Switzerland)
    Recent viewpoints on the action of systemic physical treatment.
34. J. M. POAL (Spain)
    A new device for the localized traction of the cervical spine in cases of osteoarthritis with concurrent radicular symptomatology.
35. L. J. MICHOTTE
    Les raideurs de l'épaule.
36. M. FUCHS (Switzerland)
    The syncardial method of treating peripheral vascular diseases.
37. A. STODDARD (G.B.)
    The short leg and low backache syndrome.
38. F. FORMIGAL LUZES (Portugal)
    Traitement physiothérapeutique de la poliomyélite.
39. W. D. PAUL (U.S.A.)
    Studies on the permeability of the synovial membrane.
40. K. WOEBER (Germany)
    Comparative histological researches on the primary effects of ultrasonics, ultra-short waves and hyperthermy on mitosis in Walker Carcinoma; a contribution to the effect of these agents on living cells.
41. R. SCHULZE (Germany)
    On the " secondary pigmentation " of the human skin as the result of cell-death after U.V. irradiation.
42. R. HARRIS (G.B.)
    A study of circulatory changes in skin and muscle of the hand during reflex heating, using radio-active sodium.

Friday, July 18th, 1952

Morning—Symposium on ELECTRODIAGNOSTIC METHODS

43. J. LEFEBVRE (France)
    The value of chronaxie in electrodiagnosis.

44. E. KUGELBERG (Sweden)
    Electromyography in the differential diagnosis of neuro-muscular disorders.
45. P. BAUWENS (G.B.)
    Technical advances in electrodiagnosis.

Forum: *Chairman:* F. H. Krusen (U.S.A.). *Members:* P. Bauwens (G.B.). S. Clemmesen (Denmark), F. S. Cooksey (G.B.), E. Kugelberg (Sweden), J. Lefebvre (France).

Afternoon—Proffered papers on physical measures in diagnosis and treatment

46. C. B. WYNN PARRY (G.B.)
    Electrodiagnostic methods in peripheral nerve injuries and poliomyelitis,
47. A. LUNDERVOLD (Norway)
    Muscular fatigue in man. An electromyographic investigation.
48. B. O. SCOTT (G.B.)
    Cross fire technique with short-wave diathermy.
49. J. B. MILLARD (G.B.)
    The use of electrical stimulation in the rehabilitation of knee injuries.
50. R. POHLMAN (Germany)
    The present state of ultrasonic therapy.
51. HOWARD A. RUSK (U.S.A.)
    Physical medicine and rehabilitation; a service to medicine and the community.
52. H. BALME (G.B.)
    The contribution of physical medicine in the sphere of international economy.

For those who are unable to attend the whole Congress, day tickets at one guinea admitting them to scientific sessions, the film programme and the exhibitions, may be obtained from the Honorary Secretary, 45 Lincoln's Inn Fields, London, W.C.2, or during the Congress at the Registration Bureau, King's College, The Strand, London, W.C.2.

THE PROVINCIAL TOUR

Saturday, July 19th, 1952

Morning	Visit to the Ministry of Pensions Spinal Injuries Centre. Introductory lecture by L. Guttmann.
Evening	Reception at Christ Church College, Oxford.
First night:	Oxford.

Sunday, July 20th, 1952

Free day with conducted tours of Colleges.

Second night: Oxford.

The British Association of Physical Medicine

Monday, July 21st, 1952

Morning	Visit to Churchill Hospital, Oxford. Demonstration by L. Cosin and E. F. Mason. Visit to Dorset House School of Occupational Therapy.
Afternoon	Visit to Blenheim Palace.
Evening	Performance at the Shakespeare Memorial Theatre, Stratford.
Third night:	Stratford-on-Avon.

Tuesday, July 22nd, 1952

Morning	Visit to Rehabilitation Centre, Accident Hospital, Birmingham. Introductory lecture by William Gissane. Tour of Austin Motor Company's Rehabilitation Workshop. Introductory lecture by Donald Stewart. Lunch as guests of Directors of the Austin Motor Company, L. P. Lord, Chairman of the Company, presiding.
Afternoon	Tour of Austin Motor Company's new factory.
Fourth night:	Cambridge.

Wednesday, July 23rd, 1952

Morning	Visit to Physiotherapy Department, Addenbrooke's Hospital. Conducted tour of Cambridge Colleges.
Afternoon	Visit to the Papworth Tuberculosis Village Settlement.
Evening	Sherry party at Downing College. Dinner at Sidney Sussex College.
Fifth night:	Cambridge.

Thursday, July 24th, 1952

Morning	Visit to Garston Manor Rehabilitation Centre. Lunch as guests of North-West Metropolitan Regional Hospital Board, F. Messer, Chairman, presiding.
Afternoon	Return to London.

THE BRITISH ASSOCIATION OF PHYSICAL MEDICINE

FINAL arrangements for the Scientific Programme at the Annual General Meeting on Saturday, April 26th, 1952:

Morning, at the Royal College of Surgeons

ANNUAL GENERAL MEETING.

Short papers:

(*a*) A. T. RICHARDSON. Electrodiagnosis: routine and research.
(*b*) B. O. SCOTT. Modern trends in short-wave therapy.
(*c*) W. BARLOW. The behavioural approach to postural re-education.

Afternoon, at the Royal National Orthopaedic Hospital, Stanmore

The meeting at Stanmore in the afternoon will be devoted to a Demonstration of cases of Poliomyelitis by H. J. SEDDON and DONAL BROOKS.

ABSTRACTS OF WORLD LITERATURE

Reprinted by kind permission of the editors of *The International Review of Physical Medicine and Rehabilitation*

Consulting Editor: WILLIAM BIERMAN *Editor:* SIDNEY LICHT
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Hinweise zur Ultraschalltherapie und Application. DR. G. S. NANDOR. *Med. Technik*, March, 1950, iv, 45.

The author suggests that the contradictory reports on the effectiveness of ultra-sound therapy may be due at least in part to the variations in technique and equipment. At present clinical apparatus is available at frequencies of 175, 800, 1,000, 2,400 and 3,000 kilocycles and with outputs of from 5 to as much as 100 watts. These outputs vary from 0·7 to 8·3 watts per square centimetre at radiating surfaces from 3 to 12 square centimetres. Some machines produce continuous energy and others permit interrupted or pulsating impulses. The chief difference in effect of frequencies is depth of penetration. At 175 kc. it is 20 cm., at 1,000 kc. it is 4 cm., and at 3,000 kc. it is about 1·6 cm. The reports have been equivocal in relation to frequency, for instance, peptic ulcers are said to respond to both high and low frequencies; the answer may be a matter of dosage. The depth of penetration, however, cannot be accurately determined without assuming that the tissues are homogeneous, but the distribution of sonic radiations in tissues is so variable that not even approximate data can be determined. Additional uncertainty arises from Horvath's finding that surface effects are greater with low than with high frequencies. The cavitation effect (which even in homogeneous media is ill defined) increases the complexity of the determination. It depends upon the frequency and appears at certain negative pressures especially where acoustical membrane walls are present. Its role in treatment may be related to a loosening of tissues.

The technical design of the generator is important; effective radiation depends on the dimensions of the coupling plate in the applicator head. If the frequency is not constant the output will be uneven. A 20 per cent. frequency deviation at 900 kc. may produce a drop of 15 watts in the output. The contact liquids in common use give rise to further variations. Paraffin oil is favoured because of its high viscosity, but is not the best transmitting medium. The contact medium should be homogeneous and furnish contact at every point of application and in this respect paraffin oil falls short of the desired quality. Water is better than paraffin oil and even though it requires the use of some sort of container it permits radiation at a distance from the applicator. In water, a wave reflector may be used to facilitate such areas as the soles of the feet and the prostate. If the reflector is concave the energy may be focused.

Although no specific results can be ascribed to any frequency or method of application, and even though many factors involved in ultra-sound treatment are still unknown, it is not to be ignored for it has undoubtedly helped to achieve very impressive results where other methods have failed.

Abstracts

Experimentelle Knochen-Und Sehnenlasionen Durch Ultraschall. G. MAJNO. *Strahlenther*, 1950, lxxxi, 513.

To eliminate the generalized damage of small animals exposed to ultrasound the author used rabbits for his experiments. A single paw was immersed in the ultrasonic geyser, produced on the surface of a three litre container of water. The generator had a total output of 67 watts at 960 kc.; the sound head at the floor of the container had a diameter of 6 cm. Because of the extreme painfulness of the radiation the animals were anaesthetized with narconumal and ether (inhalation). Because of its exposed position the os calcis of the hind leg was very suitable for testing. Surface absorption was eliminated by depilation. The water cooled by adding ice from time to time. Since the investigation was undertaken to study tissue destruction high energies were used. Five minutes of sounding had no gross effect except for slight warming. After two hours of exposure there was considerable oedema up to an inch above the ankle. The average exposure was 30 to 60 minutes and this always resulted in moderate ankle oedema.

No general effects were observed. Some animals died from the anaesthesia; pericarditis and broncho-pneumonia were other causes of death. Phlyctena (vesicles) measuring 5 by 5 mm. developed in the normally hairless skin over the calcaneus after a 20 to 30 minute sounding. No superficial hyperaemia was seen, but the radiated part of the extremity was very warm in spite of the very cold contact medium. Following the exposure the heel was bandaged with cotton to avoid trauma. The oedema persisted for some days and when the time of application was increased to two hours a necrosis appeared in from two to 10 days, the bone was exposed, the tendon torn and the foot hung loose.

Animals were sacrificed at different periods for histological examination. In animals killed immediately after treatment, the skin showed only minor changes; there were swollen epithelial cells in the sheaths of some hair follicles. The deep skin layers near the tendons showed vascular dilatation, the os calcis showed changes to a depth of 10 cm. superficial cartilage showed basophilic nuclei; bone cells were destroyed, epiphyseal cartilage was morphologically unchanged while the bony metaphysis beyond the epiphysis was destroyed. There was also subendosteal bleeding. At this stage the tendons did not show obvious lesions, the soft tissues showed only interstitial oedema. After three days the tendons showed necrosis and tearing; the cartilage still revealed normal nuclei. After three weeks an ulcer perforating the skin appeared. All these lesions though not specific have certain topographic characteristics; they are localized at the interfaces such as bone-endosteum, bone-periosteum, and show décollement or tearing. The author interprets these lesions as indirect, produced by cavitation at the interfaces.

The Relation Between Threshold Voltage and Frequency in Square Wave Alternating Current Stimulation. J. W. DUYFF and W. G. WALTER. *Acta Physiol. Pharm. Neerl.*, January, 1950, i, 35.

This very interesting paper compares alternating current stimulation with a sinusoidal current and with a square-wave current at different frequencies. Experiments were all made on nerve-muscle preparations of summer frogs.

Abstracts

It is found that with the use of sinusoidal alternating current the curve obtained by the present authors is very similar to the ones reported in the literature, namely, a curve symmetrical around the optimum frequency if plotted logarithmically. The square-wave curve, however, is entirely different. One finds an increase in threshold with increase in frequency, no optimum frequency in the range measured from 25 to 500 cycles per second. The experiments give an unusual support to Hill's theory of excitation, and do not seem to fit very well into those theories that claim excitation as a resonance phenomena (Monnier and others).

On the Relative Stimulating Efficacy of Sine-Wave and Square-Wave Voltages at Frequencies Exceeding the Optimum Frequency for Sine-Waves. E. M. BRUINS, J. W. DUYFF and W. G. WALTER. *Acta Physiol. Pharm. Neerl.*, May, 1950, i, 223.

The authors have compared the efficiency of sinusoidal alternating current and square-wave stimulation with frequencies from 500 to 7,500 cycles per second. The square-wave current is found to be more efficient. The efficiency quotient ranging from 1·5 at a low frequency under 500 to about 1·9 at 7,500 cycles per second.

The authors have some very interesting considerations based on the fact that if chemical concentration changes caused by the flow of the stimulating current are responsible for the occurrence of the excitatory process, the difference in efficacy between the two currents should be directly related to the admittance of conductors of the second class to the wave-forms in question.

The authors find that the relation between admittance for the square-wave voltage compared to the sine-wave voltage increases continuously with frequency, approaching a value of 2·35 at infinite frequency. There is a reasonably good agreement between theoretical deductions and experimental results.

The authors conclude that the difference in stimulating efficacy between sine-waves and square-waves is directly dependent on the difference in admittance of electrolytic conductors for the two types of currents, which again is a further argument for the view that establishment of a chemical concentration or concentration ratio is a pre-requisite for the occurrence of excitation.

Étude Electromyographie des Troubles de la sensibilite Profonde. I. LESNY, B. DRESCHLER and K. OBRDA. *Rev. Neurol.*, September, 1950, lxxxiii, 192.

Seventeen patients were examined electromyographically following posterior root sections of one or more roots, performed to relieve sciatic pain caused by herniated nucleus pulposus. In almost every patient, the muscles underlying the involved dermatomes showed a non-interfering pattern on maximal voluntary motion, a pattern commonly seen in lower motor neurone involvement. In addition, the authors investigated 23 patients (19 with tabes and four with combined sclerosis) with posterior root involvement. A non-interfering pattern was found in eight of the muscles examined; the remaining cases showed a partial interfering pattern. The authors conclude that a sensory

nerve disturbance produces abnormal electric activity in corresponding motor nerves.

This reviewer believes that patients with long-standing sciatica, tabes or combined sclerosis, may have enough motor involvement to produce electromyographic changes. The conclusion drawn by the authors is, therefore, not warranted.

El Empleo de Obreros Seriamente Incapacitados. E. J. TOOGOOD. *Med. Deporte y Trab.*, June, 1950, xv, 3442.

This is a report to Argentina of the British National Rehabilitation Service adopted in 1942. In that year there were more than 900,000 disabled in Great Britain of whom 93 per cent. were working. To employ the remaining 7 per cent. of the more seriously handicapped, a corporation called Remploy Limited was created under the Ministry of Labour. Of the 130 factories projected throughout the British Isles to employ a total of 13,000 seriously disabled people, 71 were functioning successfully in 1950. The factories, modern in every sense and designed for the handicapped worker, offer facilities for transportation and lunch, social service, medical and first-aid care. There are from 50 to 300 workers in each factory, each of whom works a full 44 hour week. Production is specially selected (orthopaedic shoes, cabinets, leather work, book binding) and the goods are sold on the open competitive market.

Treatment of the Disabled in the U.S.S.R. PROF. JAZYKOV. *Acta Chir. Ortho. Traum, Czech.*, 1950, xvii, 2.

In 1945 special sections were established in all types of Army hospitals for the rehabilitation of disabled soldiers in Russia. In addition, a research institute for orthopaedics, physical medicine and rehabilitation was established with the aim of increasing the education of physicians in the field. As a result of this work, by January, 1949, 60 per cent. of all the disabled had been rehabilitated, and of this number, 84·4 per cent. were capable of productive work.

Occupational Therapy in a General and Surgical Hospital. C. O. MOLANDER, M.D. *Arch. phys. Med.*, December, 1950, xxxi, 757.

The author lists six reasons for the failure of occupational therapy to progress in civilian hospitals. Post-war apathy, poor location of the workshop, lack of funds, lack of research, lack of medical supervision, lack of qualified therapists, especially key personnel.